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CHAPTER 4

SANITARY SEWER SYSTEM

4.00.00 INTRODUCTION

All sanitary sewer systems shall comply with the requirements of these STANDARDS AND SPECIFICATIONS and may include special criteria established by the City for overall hydraulics of the sanitary sewer system. All work performed according to this section must comply with the general requirements contained within Chapter 1 and the acceptance requirements of Chapter 10. Special criteria shall be outlined at pre-design meetings, as determined necessary by the City.

4.01.00 USE OF SANITARY SEWER

The use of sanitary sewers within the City of Delta shall be in accordance with Chapter 13.04 of the Delta Municipal Code.

4.20.00 DESIGN CRITERIA

4.21.00 SCOPE

It is the intent of this "design criteria" section to provide sufficient detailed information to enable the Engineer for the Responsible Party to correctly and efficiently design the overall sanitary sewer system for a particular development. If the City deems it appropriate to require the engineered design of a sanitary sewer system, criteria shall be made available to the Engineer to provide a design acceptable to the City. Any deviation from these STANDARDS AND SPECIFICATIONS must be approved in writing by the City.

4.22.00 GENERAL

The sanitary sewer system shall be designed by a professional engineer registered in the State of Colorado utilizing the most current technical standards along with good, sound engineering judgment throughout the design process. The design process includes the submittal of construction drawings for review and approval by the City. Construction drawings shall conform to the submittal criteria in Section 1.40.00 of these Standards and Specifications.

At the completion of the project, the engineer shall provide the City with two (2) sets of wet stamped record drawings in conformance with the submittal requirements of Section 1.40.00 of these Standards and Specifications.

4.23.00 DESIGN FLOW

The flows used to design the sewer system for a particular development vary depending on the type development. The following is a list of criteria to be used in the preparation of all sewer system analysis and design.

(A) Design flow shall be calculated using peak domestic flow rate plus maximum infiltration.

(B) Domestic wastewater flow shall be calculated using specific planning information, known or predicted, using the parameters outlined in Table 4.23.01 below. Conceptual planning information listed in the table shall be used for future flow design.

TABLE 4.23.01
Wastewater Design Flow Parameters

<u>Specific Development</u>	
Capita per Residence	2.5
Flow per Capita (gal/day)	70
Commercial/Industrial	See Table 4.23.02
Infiltration	100 gpd/in-dia/mile
<u>Conceptual Planning*</u>	
Low Density Residential	953 gpd/ac
Medium Density Residential	2540 gpd/ac
High Density Residential	5715 gpd/ac
Commercial	300 gpd/ac
Industrial/Public School	1000 gpd/ac

*Conceptual planning design flow parameters established utilizing low, medium, and high densities of 3, 8, and 18 units per acre respectively, 127 gal per capita per day.

TABLE 4.23.02
Commercial/Industrial Specific Development Design Flow Parameters

<u>Type of Establishment</u>	<u>Design Unit Flow (gpd/1000 sq ft)</u>
Office Buildings	200
Restaurants	500
Bars & Lounges	300
Hotels & Motels	350
Neighborhood Stores	200
Department Stores	200
Laundries & Dry Cleaning	1000
Banks & Financial Buildings	300
Medical Building & Clinics	300
Warehouses	100
Meat & Food Processing Plants	2800
Car Washes	1900
Service Stations	20
Auto Dealer. Repair & Service	150
Super Market	200
Trade Businesses	200
Places of Assembly – Churches, etc.	600
Hospitals	450 gal/bed

(C) Peaking factors for residential areas shall be as per Table 4.23.03 below. For all commercial and public facility uses, the peaking factor shall be 2.0. Industrial peaking factors shall be industry specific based on metering information and must be approved by the City.

TABLE 4.23.03
Residential Development Peaking Factors

<u>Service Population</u>	<u>Peaking Factor</u>
110	3.6
112	3.5
125	3.4
150	3.3

175	3.2
200	3.1
250	3.0
300	2.9
350	2.8
450	2.7
500	2.6
Greater than 500	Contact City

(D) Infiltration for future sewers shall be accounted for using 100 gpd per inch diameter per mile of sewer line. Special consideration shall be given for areas of high ground water.

4.24.00 HYDRAULIC DESIGN/SIZING OF SEWER LINES

4.24.01 General

Sanitary sewer shall be designed to carry the discharge calculated in accordance with Section 4.23.00 and to transport suspended material such that deposits in the sewer are precluded. The following table gives the recommended capacity criteria for sanitary sewer mains:

TABLE 4.24.01
Recommended Capacity Criteria

Diameter (Inches)	Flow Depth Restriction (d/D)
Less than or equal to 15"	0.50
Greater than 15"	0.75

The minimum diameter for sanitary sewer mains shall be 8-inches.

Oversizing of mains may be required by the City, and the recovery of the costs of such oversizing shall be the responsibility of the City.

The minimum diameter for sanitary sewer service lines shall be 4 inches.

4.24.02 Sanitary Sewer Mains

(A) The following table gives the minimum and maximum allowable slopes for sanitary sewer mains:

TABLE 4.24.02
Sanitary Sewer Main Slope Criteria

Diameter (Inches)	Minimum Slope (Feet/Feet)	Maximum Slope (Feet/Feet)
8	0.0040	0.0180
10	0.0030	0.0120
12	0.0020	0.0100
15	0.0015	0.0080
18	0.0012	0.0090
21 or larger as approved by City		

Sewer line design shall incorporate the largest slope possible within the requirements of Table 4.24.02 and shall maintain a uniform slope between manholes.

- (B) The sewer must be designed at a slope great enough to produce a minimum flow velocity of two feet (2') per second and a maximum flow velocity of ten feet (10') per second at the peak design flow using the Manning equation and Manning's n values as indicated in Table 4.24.03 below except that the slope shall never be less than the minimum slope given above:

TABLE 4.24.03
Manning's n Values per Pipe Material

<u>Sewer Line Material</u>	<u>Manning's n Value</u>
PVC	0.009
RCP	0.013

Hydraulic design of pressure sanitary sewers shall be in accordance with chapter 3 of these standard specifications.

4.24.03 Sanitary Sewer Service Lines

The following table shows the minimum and maximum allowable slopes for sanitary sewer service lines:

TABLE 4.24.04
Sanitary Sewer Service Slope Criteria

<u>Diameter (Inches)</u>	<u>Minimum Slope (Feet/Feet)</u>	<u>Maximum Slope (Feet/Feet)</u>
4	0.020	0.040
6	0.020	0.030

4.25.00 SYSTEM LAYOUT

4.25.01 General

All mains shall be installed in dedicated rights-of-way or public easements. Under no circumstances should sanitary sewer mains be installed parallel to and directly below any concrete such as sidewalks, curbs or gutters. Lines shall normally be located five feet south or west of street centerline, unless otherwise approved, in writing, by the City. Sanitary sewer mains shall be straight between manholes, both in horizontal and vertical alignment.

Sewer mains will ordinarily have a minimum of eight feet of cover to finished ground surface. Where this will provide less than nine feet of elevation difference between the finished lot grade at building line and the top of the sewer main, it will be indicated on the plans that the lot is served by a "shallow sewer" and appropriate elevation information will be given.

Sewer mains shall extend to the uppermost property line unless otherwise approved by the City. The City may participate in an extension if deemed appropriate to serve future users. Sewer mains shall terminate in a manhole. During a phased utility plan, the sewer main may be

temporarily allowed to dead end in a cleanout provided the main extends no more than 50 feet from the last manhole and a maximum of two (2) residential connections exist. The cleanout provided shall be in accordance with the detail drawing in the Appendix of this Chapter.

Sanitary sewer mains shall be laid a minimum of ten feet horizontally from any existing or proposed utility. Upon written approval by the City, a sanitary sewer main may be laid closer than ten feet to a parallel water main if it is laid in a separate trench and if the elevation of the invert of the water main is at least eighteen inches above the crown of the sewer main and, in addition, polyvinyl chloride pressure pipe is used for the sewer main.

When the sanitary sewer main passes under a highway, railroad or drainage or irrigation ditch, there shall be a minimum of 3-1/2 feet of cover and steel casing shall be installed in accordance with the detail drawing in the Appendix of this chapter. The steel casing shall extend the entire width of the right-of-way or easement of the crossing structure or as directed by the City.

4.25.02 Waterline Crossing Over or Under A Sanitary Sewer Line

See Section 3.18.02 of these Standards and Specifications.

4.25.03 Storm Sewer Line Crossing Over or Under Sanitary Sewer Line

When there is less than 18 inches of vertical clearance between the sanitary sewer line and the storm sewer line, the sanitary sewer line shall be encased in concrete a minimum of ten feet on each side of the centerline of the crossing or polyvinyl chloride pressure pipe in accordance with American Water Works Association C900 may be used. In the case of of the sanitary sewer crossing over the storm sewer, each joint of the storm sewer within 9 feet of the centerline of the crossing shall be encased in concrete.

4.25.04 Limits On Vertical Separation

Under no circumstances shall the vertical clearance between any lines involving a waterline, sanitary sewerline, or storm sewer be less than 12 inches without prior written approval from the City.

4.26.00 EASEMENTS

See Section 3.19.00 of these Standards and Specifications.

4.27.00 FUTURE CONNECTIONS

Manholes shall have a full joint of pipe stubbed out which are sized to accommodate flows from the upstream basin whenever a future extension of the sanitary sewer main is anticipated. The main line stub-out shall be capped and sealed.

4.28.00 SERVICES

Each structure shall be served by a separate service line. Sanitary sewer service lines shall be located a minimum of ten feet away from all water services (measured horizontally). Whenever possible, service lines shall be constructed perpendicular to the property line of the property they are going to serve and shall be located a minimum of 10 feet from either property line. Six inch service lines and larger shall require connection to the main with a manhole. Service connections shall not be allowed onto an

interceptor sewer (i.e. any sewer line greater than 12" in diameter) without prior approval of the City. The point where the service line crosses under the curb, if applicable, shall be marked by chiseling a symbol "S" on the curb face.

The City shall not be held responsible for the locating of sewer service lateral stub-outs for future connections.

4.29.00 TAPS

All sanitary sewer service connections to the sanitary sewer main shall be made using "wye" fittings, unless otherwise approved by the City.

4.30.00 UNLAWFUL CONNECTIONS

It shall be unlawful to discharge roof drainage, foundation drainage, sump pumps, surface drainage or any other non-acceptable wastes to the sanitary sewer which would violate any of the provisions of Chapter 13.08.020 of the Municipal Code.

4.31.00 WASTEWATER PRE-TREATMENT

All uses shall be evaluated to determine whether the provisions of Chapter 13.08 of the City of Delta Municipal Code shall apply prior to being issued a final Certificate of Occupancy. If these provisions do apply, an approved pre-treatment device shall be installed per these Standards and Specifications and Section 4.32.05.

4.32.00 APPURTENANCES

4.32.01 Manholes

The maximum spacing between manholes shall be 400 feet for sewer pipe diameters of 15" or less. For sewer pipe diameters of greater than 15", the maximum spacing shall be 500 feet. Manholes shall be provided at every change in grade, sewer line diameter, or intersection of sewer line equal to or larger than 15" in diameter. Manholes shall also be provided at every change in direction with the exception of sewer lines 24" in diameter or larger with a change in direction of flow less than 45 degrees. Manholes shall have a minimum diameter of 48" for all sewer pipe diameters less than 27". For sewer pipe diameters greater than 27", the minimum manhole diameter shall be 60". The drop across a manhole base should match the larger of the incoming or outgoing slope but shall not be less than 0.2 foot per one foot. For manholes under the following conditions, a corrosive protective material coating shall be installed within the interior; manholes providing a change in direction equal to or greater than 45 degrees (for pipe diameters smaller than 24"), manholes in line with or at the end of sewer lines with City-preapproved slopes greater than that set forth in these criteria, manholes accepting flow from an outside drop or any form of anticipated septicity, or as required by the City.

Manholes shall not be located in areas that are subject to flooding from surface runoff. Manholes shall be located in within utility easement areas that allow direct access by maintenance vehicles when it is not feasible to locate the manhole in the public street. If the possibility of surface runoff cannot be avoided, an internal watertight insert shall be installed to prevent inflow. All manholes located outside dedicated street rights-of-way shall be designed and constructed with locking-type cover and the manhole ring shall be bolted to the manhole cone.

4.32.02 Outside Drop Manholes

Drop manholes will only be allowed when the design engineer proves that alternates are not feasible and when approved, in writing, by the City. Outside drop manholes will be required whenever a sewer entering a manhole is at an elevation twenty-four inches or more above the manhole invert. Outside drop manholes shall be in accordance with the Detail Drawing in the Appendix of this chapter. Outside manhole drops require filleting to avoid solids deposition. The entire outside drop piping shall be encased in concrete. No inside drops are allowed.

4.32.03 Underdrains

Where underdrains are to be constructed under sewer mains, separate clean-outs shall be provided next to each manhole in accordance with the Detail Drawing in the Appendix of this chapter. Further, all underdrain service lines originating from within lots shall meet these requirements including size, marking tape and sock.

4.32.04 Liftstations

Lift stations will only be allowed when the design engineer proves that this is the only option available and when approved, in writing, by the City. The City shall dictate the location and type of pumping facilities to be constructed and to require extra maintenance from the Responsible Party. The City will require the lift station to contain a separate emergency power backup in cases of power outages.

4.32.05 Gravity Grease and Soil/Oil Interceptors (Interceptor)

Any new establishment, including but not limited to Food Service Establishments (FSE) and automotive related facilities, that may contribute fats, oils, grease (FOG), sand, mud, petroleum based oils, or any other potentially damaging pollutant to the City's wastewater treatment system shall be required to install and maintain, at the owner's expense, a properly designed and constructed interceptor. In addition, any existing facility that contributes FOG, sand, mud, petroleum based oils, or any other potentially damaging pollutant to the City's wastewater treatment system may be required to install and maintain, at the owner's expense, a properly designed and constructed interceptor. Specific sizing design criteria shall be obtained from the City.

Unless otherwise approved, all exterior interceptors shall meet the following minimum standards and must be approved by the City prior to installation:

1. Engineer designed and constructed for its intended purpose.
2. Precast concrete construction, reinforced to 4000 PSI minimum compressive strength at 28 day.
3. Conforming to H-20 load rating standards if installed in vehicle traffic areas.
4. At least 2 separate chambers separated by 1 baffle between any 2 chambers, the volume of the first chamber occupying approximately 2/3 of the total volume of the interceptor.
5. 2 manholes of 24" minimum diameter for each chamber, located above the inlet and outlet pipe.
6. Minimum 4" diameter inlet pipe. Outlet pipe must be equal or greater diameter than inlet.
7. Inlet pipe must have a T, the bottom of which must extend no more than 1/2 the depth of the liquid.
8. Outlet pipe must have a T, the bottom of which must extend no less than 12" above the tank floor. At no time may the outlet pipe T be capped. Outlet filters shall not be installed.

9. The inlet and outlet inverts shall differ by a minimum of 2" and a maximum of 4".
10. A separate inspection/sampling chamber may be located in the discharge line beyond the interceptor but shall not be installed in place of the outlet pipe T.
11. Designed such that it shall not become air-bound if an airtight cover is used.
12. Interceptor shall be designed as close as possible to the establishment and shall be readily accessible for cleaning, maintenance, and inspection.
13. Interceptor shall be designed such that the retention time is at least 30 minutes.

As an alternate to the above described concrete interceptor, the City will allow an interceptor constructed of fiberglass designed and manufactured by Green Turtle of Charlotte, NC. The appropriate fiberglass interceptor shall be the Proceptor® fiberglass interceptor.

4.32.06 Hydromechanical Grease Interceptors

A FSE may request an exemption to Section 4.32.05 if the establishment can show that such installation is not feasible due to physical or other limitations that would make it impractical to install an Interceptor. Such request shall be made in writing and, if approved by the City, the establishment shall be required to install and maintain, at the owner's expense, a hydromechanical grease interceptor. Such interceptor shall be constructed and sized to conform to the Plumbing and Drainage Institute Standard G-101 (PDI G-101), shall be installed according manufacturer's and International Plumbing Code requirements, and shall be located as close as possible to the source of the grease-producing fixture.

4.39.00 CONSTRUCTION SPECIFICATIONS

4.40.00 EXCAVATION AND TRENCHING

Excavation, trenching and backfilling shall be done in accordance with Chapter 9 of these STANDARDS AND SPECIFICATIONS.

4.41.00 BEDDING

4.41.01 General

In the event unstable trench conditions are found at pipeline grade, a minimum of one and one-half inch uniformly graded, washed rock shall be used for trench stabilization. Depth of stabilization shall be as approved by the City. Pipe bedding shall be done in accordance with Sections 4.41.00 of these STANDARDS AND SPECIFICATIONS and the Detail Drawing in the Appendix of this chapter.

4.41.02 Class A Bedding

Class A bedding is defined as that method of bedding in which the lower half of the pipe is set in a reinforced concrete cradle. The minimum thickness of concrete under the lowest part of the conduit shall be one-fourth of the outside pipe diameter but not less than four inches. The concrete shall extend around the pipe to the spring line of the pipe barrel. The width of the concrete cradle shall be at least equal to the outside pipe diameter plus eight inches.

4.41.03 Class B Bedding (Granular II)

Class B bedding is defined as that method of bedding in which the pipe is set on granular material meeting the requirements of Chapter 9 in these STANDARDS AND SPECIFICATIONS.

Bedding shall be placed to a depth below the bottom of the pipe equal to one-fourth of the outside pipe diameter but not less than four inches. In rock excavation this minimum depth shall be six inches. Granular material shall be placed around the sides of the pipe and to a minimum of twelve inches above the top of pipe.

4.42.00 PIPELINE INSTALLATION

4.42.01 General

The City shall be notified at least 48 hours in advance of any pipe installation. The Responsible Party shall notify and arrange for all utility locates prior to excavation. No pipes shall be backfilled until they have been inspected and approved by the City. Alignment and grade of the pipe and the location of fittings, and manholes shall be staked under the supervision of a professional surveyor registered in the State of Colorado.

Proper implements, tools and facilities shall be provided and used by the Responsible Party for the safe and convenient execution of the work. All pipe fittings, and manhole sections shall be carefully lowered into the trench by means of a derrick, ropes or other suitable tools or equipment to prevent damage to sanitary sewer line material. Under no circumstances shall sanitary sewer line materials be dropped or dumped into the trench.

All pipe fittings shall be carefully examined for cracks and other defects immediately before installation. The groove in the bells of the pipe shall be full and continuous or the pipe will be rejected. Defective pipe or fittings shall be removed from the job site within 24 hours of notification by the City. All foreign matter or dirt shall be removed from the interior and ends of the pipe before they are lowered into position in the trench and prior to connection.

Every precaution shall be taken to prevent foreign material and trench water from entering the pipe and fittings. During construction, the Responsible Party shall provide and maintain adequate equipment to properly remove and dispose of all water entering the trench and any other part of the work.

A green plastic identification strip, a minimum of three-inch wide, continuously labeled "Caution Sewer Line Below" shall be installed directly above all gravity sewer main, the full length of the sewer, and shall be buried two feet below the finished ground surface elevation. For pressure sewer main, a brown plastic identification strip, a minimum of two-inch wide, continuously labeled "Caution Buried Force Main Below" shall be installed directly above the pressure sewer, the full length of the sewer, and shall be buried two feet below the finished ground surface elevation.

4.42.02 Pipe

Pipe shall be laid from downstream to upstream with spigot ends pointing downstream. All pipe shall be placed true to line and grade and carefully centered and with a smooth invert at the joint. Pipe shall be laid with a pipe laser or similar instrument to insure proper grade is maintained. Any pipe installed at a slope less than 1% shall have a plate-tamped trench bottom to insure proper grade is maintained. The joint shall be made in a workmanlike manner and shall be watertight. Immediately before joining two lengths of pipe, the inside of the bell and the outside of the spigot end and the gasket shall be thoroughly cleaned. Caution shall be exercised to ensure that the correct type of gasket is used. A thin film of gasket lubricant shall be applied to the inside face of the gasket and the spigot end of the pipe. The spigot end of the pipe shall be placed in the bell with care to prevent the joint from contacting the ground. The joint shall be completed by pushing

the pipe home by hand with a slow steady pressure, without jerky or jolting movements. Pipe furnished without a depth mark shall be marked before assembly to ensure insertion to the full depth of the joint. The pipe shall then be properly set and brought to correct line and grade. The pipe shall then be secured in place by installation of bedding material and backfill, in accordance with Chapter 9 and the detailed drawings in the Appendix of this chapter.

At times when installation is not in progress, the open ends of the pipe shall be closed with a watertight plug. Cutting of pipe for inserting closure pieces shall be done in a neat and workmanlike manner without damage to the pipe or lining, leaving a smooth end at right angles to the axis of the pipe. Pipe ends shall be smooth and beveled with a file or other tools according to the pipe manufacturer's recommendations.

Extra care should be used in handling PVC pipe during cold weather due to the reduced flexibility and impact resistance as temperatures approach and drop below freezing. PVC pipe to be stored outside and exposed to sunlight for more than 30 days shall be covered with an opaque material such as canvas. Clear plastic sheets shall not be used to cover the pipe. Air circulation shall be provided under the covering. Any over-exposed pipe, as determined by the City, will not be permitted for installation.

No pipe or appurtenant structure shall be installed upon a foundation in which frost has penetrated or at any time when the City deems there is a danger of ice formation or frost penetrations at the bottom of the excavation. No pipe or appurtenant structure shall be installed unless backfilling can be completed before the formation of ice and frost.

4.43.00 MANHOLE CONSTRUCTION

4.43.01 Cast-in-Place Base

Manhole bases shall be constructed with Class A concrete, placed on undisturbed ground and in conformance with the detail drawing in the Appendix of this chapter. Changes in direction of flow through the manhole shall be made with a smooth curved channel having as large a radius as possible. The change in size of channels shall be made gradually and evenly and shall be formed directly in the concrete. The floor of the manhole outside of the channel shall be finished to a brushed surface.

Concrete bases shall extend at least eight inches below the invert of the pipe and shall be benched to at least two inches over the top of the pipe. The manhole floor between the sewer pipe and the outer portions of the bench shall be flush with the top edges at the pipe spring line and shall slope upward at least two inches per foot. Wherever grade and alignment permit, the sewer shall be laid continuously through the manhole and the manhole built later. In such cases, the foundation shall be placed as mentioned above and once the manhole is constructed, the upper half of the pipe shall be sawed out and the rough edges smoothed with cement mortar. Breaking out the top of the pipe is not permitted

Where it is not practicable to use split pipe through manholes due to breaks in alignment, grade, or elevation of intersecting sewers, the sewer invert shall be made of concrete deposited between forms. The shape of the invert shall conform to the lower half of the pipe it connects. Side branches shall be constructed with as large a radius of curvature as possible. Inverts shall be plastered with cement mortar and left smooth and clean. Where called for on the plans, a pipe bell shall be stubbed out and plugged. The bell shall be placed as close to the manhole wall as possible, unless showing otherwise on the approved plans.

Reinforcement will be required in the manhole base when the distance from the pipe invert to the top of the manhole cover exceeds 15 feet or when poor soil conditions exist. Reinforcement shall be approved by the City prior to installation.

4.43.02 Pre-Cast Base/Inverts

Pre-cast bases will be allowed by the City and shall be in conformance with this section.

The ground surface below the precast concrete base shall be excavated three inches below the elevation of the bottom of the base and backfilled with three quarter inch gravel meeting the requirements of Section 9.22.00. The gravel shall be carefully leveled and smoothed to give uniform support to the precast base over its entire area. The precast base shall be set at the proper location to center the manhole over the sewer main.

The precast base shall also conform to the requirements of Section 4.43.03 of these STANDARDS AND SPECIFICATIONS.

4.43.03 Pre-Cast Barrel

Precast manhole sections shall not be placed on the foundation until it has reached sufficient strength to provide support without damage. The joint between the manhole base and the barrel section shall be made with a flexible butyl resin joint sealing compound. Each succeeding precast section shall be joined in a similar manner and smoothly finished, inside and out.

4.43.04 Manhole Grouting Treatment

The horizontal joints between precast manhole sections shall be plastered and troweled smooth, inside with cement mortar in conformance with Section 4.64.05 if deemed appropriate by the City Representative. The mortar shall be not less than five-eighths inch in thickness over the joint and shall extend at least four inches on either side of the joint.

All smooth surface pipes, such as PVC or VCP shall have a manhole water-stop gasket, to be furnished by the Responsible Party, firmly attached to the pipe prior to grouting into the manhole. The opening in the manhole wall where a pipe enters or leaves shall be sealed and patched in a neat workmanlike manner, both inside and out with cement mortar. All lifting holes and other imperfections in the interior manhole wall shall be filled with cement mortar.

4.43.05 Adjustment Rings

Precast concrete adjustment rings shall be used on top of the cone to support and adjust the manhole frame to the required final grade. The maximum depth of the adjustment rings shall be twelve inches, and the maximum depth from top of cone to final grade shall be eighteen inches.

The top elevation of the manhole shall be adjusted to match final street grade. If manholes are located in open fields, they shall be left at least eighteen inches above grade and a locking ring and cover shall be installed. In cultivated areas, manholes shall be properly marked by a steel post painted red on the top six inches and located five feet from the centerline of the manhole cover.

4.43.06 Cleanouts

Cleanouts shall be installed next to the manhole base in conformance with the detail drawing in the Appendix of this chapter where an underdrain is installed with the sanitary sewer system. Cleanouts may also be used as discussed in Section 4.25.01.

4.44.00 CONNECTIONS TO EXISTING MANHOLES

Sewer pipe connections to existing manholes where there is no existing pipe stubbed out shall be made in such a manner that the finished work will conform as nearly as practicable to the requirements specified for new manhole construction. The Responsible Party shall carefully cut out as small an opening in the existing manhole as necessary to insert the new sewer pipe. The existing concrete foundation bench shall be ground out for a new invert with a hand grinder to the cross-section of the new pipe in order to form a smooth continuous invert similar to what would be formed in a new concrete base. Where practical, the downstream invert shall be plugged during construction to prevent storm and non-sewage flow from entering the system. The Responsible Party shall pump out and clean the manhole before removing the plug. Cement mortar shall be used to smoothly finish the new invert and to seal the new line, both inside and outside, so the junction is watertight.

4.45.00 UNDERDRAINS

4.45.01 General

Where excessive ground water is encountered, the City may require construction of a piped underdrain, to reduce infiltration. Underdrains shall be daylighted to the nearest suitable point as approved by the City.

Underdrain main construction shall be done in accordance with engineered construction plans for the work prepared under the direction of a registered professional engineer and approved by the City.

Soil samples are a prerequisite to the underdrain system. A written proposal on the underdrain system must be presented to the City of Delta before the Construction Agreement is approved.

4.45.02 System Layout

Underdrain shall be placed in its own trench approximately 1-1.5 feet below sanitary sewer main, unless otherwise approved by the City Representative.

All underdrain cleanouts should be located in either a storm sewer vault or in its own valve box. Underdrain cleanouts will not be permitted in sanitary sewer manholes.

4.45.03 Materials

All underdrains shall be constructed in perforated and/or non-perforated SDR-35 PVC pipe, with a tracer wire attached for locating purposes.

A minimum of 6-inch PVC pipe shall be used for all underdrain mains and services.

Underdrains shall be lined in filter fabric prior to installation only if perforated.

4.45.04 Mapping

Record drawings shall be provided to the City prior to date of acceptance. All maps must provide adequate details of the underdrain prior to being accepted by the City.

4.45.05 Inspections

Underdrain mains will be thoroughly inspected by the City Representative prior to backfill.

Underdrain cleanouts must be located outside of sanitary sewer manholes, as detailed in the Construction Agreement.

Underdrain daylights shall be free from being covered by dirt. An engineering drawing of all proposed daylights shall be submitted prior to City approval.

4.45.06 Bedding

Granular bedding material shall be installed a minimum of 12 inches above the top of the pipe.

Backfill must be placed in lifts not exceeding 12 inches.

4.45.07 Compacting Ordinary Backfill

All trenching, backfilling and compaction of underdrain shall be done in accordance with Chapter 9 of these STANDARDS AND SPECIFICATIONS.

4.46.00 PRESSURE SEWERS

All requirements of Chapter 3 of these STANDARDS AND SPECIFICATIONS shall apply to the installation of pressure sanitary sewer lines. All pressure sanitary sewers shall be installed using PVC C-900 per AWWA for 6" diameter or greater pipe. For pipe 4" diameter or smaller, pipe shall conform to AWWA Schedule 40 class 200 PVC. If pressure sewers are allowed by the City, design will include cleanouts and lift stations according the City.

A brown plastic identification strip, a minimum of a two-inch wide, continuously labeled "Caution Buried Force Main Below" shall be installed directly above the pressure sewer, the full length of the sewer, and shall be buried two feet below the finished ground surface elevation. Responsible party has the option of installing either a metallic identification strip or tracer wire along the pipe in conformance with Section 3.33.02 of these Standards and Specifications.

4.47.00 SANITARY SEWER SERVICE LINE CONSTRUCTION

All sanitary sewer service lines that connect to the City of Delta sanitary sewer system shall comply with these STANDARDS AND SPECIFICATIONS and the most current City adopted Uniform Plumbing Code.

The Responsible Party shall place wyes, stubs, and risers where required by the approved plans. Wyes shall be angled upwards so that the upper invert of a one-eighth bend connected to the fitting will have an elevation equal to or higher than the inside crown of the sewer main. Riser connections shall be installed

where the elevation of the top of the branch is more than twelve feet below the approved finished grade. Riser connections will ordinarily reach to a grade ten feet below the finished ground surface. Watertight plugs shall be installed in each branch pipe or stub. As-built measurements shall be made by the Responsible Party or his representative to reference the wye or riser connection to the nearest manhole as well as the depth from the finished grade elevation to the invert of the stub before backfill is completed. Said measurements shall be carefully and accurately made and recorded and shall be shown on the as-built plans furnished to the City prior to acceptance.

All installation work shall conform to applicable portions of ASTM C-12 and to the pipe manufacturer's installation instructions. The grooves shall be cleaned free of all foreign materials prior to assembling the joint. The pipe shall be laid with the spigot end pointing in the direction of the flow.

Trenches shall be kept free of water during laying and jointing. Lines longer than fifty feet shall be laid with batter boards, a laser, or other means approved by the City.

Clean-outs are required at a minimum interval of one hundred feet or at all bends exceeding 60 degrees or changes in grade. The area around a clean-out shall be graded so water runs away from the clean-out. No clean-outs, other than those installed as part of the sewer main underdrain system, shall be installed in publicly owned rights-of-way or easements.

Service stub-ins shall be extended at least 10' into the property and be plugged with a compression stop. Service stub-in locations shall be marked with a green post or pipe for future location and connection.

Backfilling shall be in accordance with Chapter 9 of these STANDARDS AND SPECIFICATIONS.

4.48.00 TAPPING EXISTING SANITARY SEWERS

Where tees have not been installed in the sewer main, the main shall be tapped by machine drilling a hole sized to fit the saddle for the service line. The drilling machine, method of drilling, and the saddle shall be approved by the City. The saddle shall be sealed when attached to the main and held in place with metal straps or other approved methods.

4.49.00 TESTS

4.49.01 General

All sanitary sewer mains, storm sewer mains, and appurtenances shall be cleaned and tested after backfill operations have been completed and compaction test results have been submitted to and approved by the City. Should the City find that the completed line or any portion thereof fails any of the specified tests, the City will not accept the new sewer line until such time as the sewer line meets the test specifications. Once the sewer line is completed the Responsible Party shall perform an air test and lamp test on the completed line. The use of alternate testing methods may be allowed or required in addition to those stated herein and determined necessary by the City. Alternate testing methods include water exfiltration test, infiltration test, deflection test, and television inspection.

The Responsible Party shall furnish all labor, materials, tools and equipment necessary to clean the pipe and appurtenances, make the tests and perform all work incidental thereto with the exception of a television inspection which the City will perform. Any damages to the pipeline caused by cleaning or testing operations shall be repaired or replaced by the Responsible Party at his expense.

4.50.02 Air Tests

The Responsible Party shall perform these tests with suitable equipment specifically designed for air testing sewers. The pipe, or sections of concrete pipe to be tested, may be wetted before the air test. The line shall be plugged at each manhole with pneumatic balls. All service plugs shall be secured in place to prevent displacement during testing operations. Low pressure air shall be introduced into the plugged lines until the internal air pressure reaches 4.0 psi plus 0.4 psi per foot of water table above the pipe invert, if any. At least two minutes shall be allowed for the air temperatures to stabilize before readings are taken and the timing started.

The portion being tested shall pass if it does not lose air at a rate to cause the pressure to drop from 3.6 to 3.0 psi (plus any adjustments for water table pressure as mentioned previously) in less time than listed below:

<u>Pipe Diameter</u> <u>In Inches</u>	<u>Minimum Allowable Minutes</u> <u>3.6 to 3.0 psi Pressure</u>
4	3.0
6	3.0
8	4.0
10	5.0
12	6.0
15	7.0
18	9.0
21	10.5
24	12.0

If the installation fails this test, the testing equipment may be used to determine the location of the pipe leak.

4.49.03 Deflection Test:

The maximum vertical deflection allowed for PVC pipe is five percent. The City may require the Responsible Party to perform deflection tests of the pipe before acceptance. Optional devices for testing include calibrated television, photography, properly sized go-no-go mandrel, sewer ball, or deflectometer. The method used shall be approved by the City. To insure accurate testing, the line shall be thoroughly cleaned prior to testing. Testing shall be done no sooner than 30 days after the pipe has been backfilled.

The Responsible Party shall schedule the test with the City 48 hours prior to the test and the City shall be present during the test and shall verify the accuracy of the equipment used. The City may require the Responsible Party to perform another deflection test prior to the end of the warranty period.

4.49.04 Lamping Test

Prior to acceptance into the one-year warranty period of the pipeline installation, the City shall perform a lamp test to verify the alignment and condition of the pipe. The lamp test shall be performed only after the Responsible Party has completely cleaned the line to the satisfaction of the City. Should the lamp test indicate an alignment problem, the City shall be the sole judge of the need for replacement. Unsatisfactory alignment may be the cause for rejection. The Responsible Party shall furnish the light source to be used in the lamp test and the labor necessary for the City to perform the test.

4.49.05 Pressure Test for Pressure Sewers

After the pipe has been laid, including fittings, thrust blocks, and backfill in accordance with the specifications, it shall be subjected to a hydrostatic pressure of not less than 150 P.S.I. for one hour. The allowable leakage shall not exceed the following formula:

$$L = \frac{ND}{7400P}$$

L = Allowable Leakage in Gallons Per Hour
N = Number of Joints in Length of Pipeline Tested
D = Nominal Diameter of Pipe in Inches
P = Average Test pressure during the Test, PSIG

Each valved section or the entire line if there are no valves, shall be slowly filled with water and the specified test pressure, measured at the highest point of elevation, shall be applied by means of a pump connected to the pipe in a satisfactory manner. The pump, pipe connection, gauges, and all necessary apparatus shall be furnished by the Responsible Party. Gauges and measuring devices shall be approved by the City and the necessary taps made as required by the Responsible Party. Before applying the specified test pressure, all air shall be expelled from the pipe. To accomplish this, taps shall be made at the highest elevations of the test section and plugged with brass plugs once the pipeline has passed the test.

Any cracked or defective pipes, fittings, or valves, discovered in the pressure test shall be removed and replaced by the Responsible Party with sound material. The test shall be repeated until the pipeline passes the pressure test and is accepted by the City.

4.49.06 Manhole Leakage Test

Manholes shall be tested for leakage separately from the pipe when deemed appropriate by the City Representative. The sewer pipe in the manhole shall be plugged. If the ground water table is below the invert, the manhole shall be filled with water to a depth five feet above the invert. If the ground water table is above the invert of the manhole, then the manhole shall be filled to a level at least three feet above the ground water table or to the top of the uppermost precast manhole section, whichever is less, but not less than five feet above the invert. After soaking for one hour, the manhole shall be filled to the original level. It shall then be tested for two hours. The allowable drop in the water level shall be one inch. No manhole shall be accepted that has any visible infiltration when empty. Any manhole whose test is unsatisfactory shall be repaired at the Responsible Party's expense and retested until satisfactory results are obtained.

4.49.07 TV Inspection

The City will perform TV inspections of all new sewer lines and all defects that have been repaired prior to acceptance.

In order to be considered for inspection, the improvements shall have been completed, accessible and cleaned sufficient to allow for detailed inspection by the City. When requested by the City, the Owner shall provide personnel and equipment to assist in the inspection process.

4.59.00 MATERIAL SPECIFICATIONS

4.60.00 GENERAL

Only those pipeline materials described in this section are approved for sanitary sewer installations. Any other material proposed as an equal shall be approved by the City prior to construction. All pipe materials to be incorporated in the construction of sanitary sewers shall conform to the requirements specified herein or as modified elsewhere in these STANDARDS AND SPECIFICATIONS. All materials furnished shall be new and undamaged. Everything necessary to complete all installations shall be furnished and installed whether shown on the approved drawings or not, and all installations shall be completed and fully operational. Acceptance of materials or the waiving of inspection thereof shall in no way relieve the Responsible Party of the responsibility for furnishing materials meeting the requirements of these STANDARDS AND SPECIFICATIONS.

All materials delivered to the job site shall be adequately housed and protected to ensure the preservation of their quality and fitness for the work.

4.61.00 DEFECTS

The presence of any of the following defects in an individual pipe, or in a shipment of pipe, may constitute sufficient cause for rejection of the pipe. Rejected materials shall be removed from the work site within 24 hours unless otherwise permitted by the City.

- Pipe length varying more than two inches from the specified length. Pipe shall not be ordered in random lengths.
- Pipe having a deviation from straight which exceeds the following:

$$\frac{\text{Length of Pipe in Feet}}{32} = \text{Maximum Deviation in Inches}$$

- Porous areas on either the inside or the outside surface of a concrete pipe having an area of more than five square inches and a depth of more than one-half inch.
- Pipe which has been patched or repaired without written approval of the City.
- Exposure of the reinforcement.
- Pipe damaged during shipment or construction.
- Any deficiencies noted in applicable ASTM Specifications

4.62.00 CERTIFICATION

A manufacturer's certification that material was manufactured and tested in accordance with applicable ASTM designations, together with a report of all test results, may be required by the City prior to final acceptance of the work.

4.63.00

PIPE

4.63.01 Polyvinyl Chloride Pipe (PVC)

Polyvinyl chloride pipe is the preferred material for all sewer line construction. All pipe materials and fittings shall meet the minimum requirements of ASTM D-3034, SDR-35, latest revision. Pipe shall be subjected to drop-impact tests in accordance with ASTM D-2444. The pipe shall have bell and spigot joints with gasketed joint. The spigot end shall be marked so the installer and the inspector can determine when the pipe is properly inserted into the bell. The maximum pipe length shall be twenty feet.

Minimum wall thickness shall be:

Pipe Diameter (Inches)	4	6	8	10	12
Wall Thickness (Inches)	.125	.180	.240	.300	.360

All fittings and accessories shall be as manufactured and furnished by the pipe supplier and have bell and/or spigot configurations compatible with that of the pipe.

PVC pipe and all fittings shall conform to Sections 3.52.01 and 3.53.00 of these standards and specifications.

Pipe stiffness for all pipe sizes shall be tested in accordance with ASTM D-2412. Joint tightness shall be tested in accordance with ASTM D-3212.

4.63.02 Reinforced Concrete Pipe (RCP)

Reinforced concrete pipe shall only be used when the design engineer can provide sufficient proof as the positive benefit/cost ratio to the City. If RCP is to be used, it shall be T-Locked lined and a product life span or benefit/cost calculations should be provided in order for the City to determine the benefit of use.

Reinforced concrete pipe in sizes twenty-one inches or larger shall conform to the requirements of the standard specifications for reinforced concrete sewer pipe, ASTM Designation C-76 for Classes II, III, IV, and V and as modified in this Section.

All RCP shall be constructed with Type II modified cement. The absorption of the pipe shall not exceed 5.5 percent of volume.

All concrete pipe fittings, wyes, tees, and bends shall be cast as an integral part of the pipe to which they are attached and shall be the same pipe classification.

The following shall be clearly marked on the exterior surface of all pipe with waterproof paint.

- ASTM Specification.
- Class and Size.
- Date of Manufacture.
- Name or Trademark of Manufacturer.

4.64.00

MANHOLES

4.64.01 General

Manholes, reducing sections, ladder rungs and traffic lids shall be precast and conform to ASTM Standard Designation C-478. All traffic lids shall be designed for AASHTO H-20 traffic loading. All ladder rungs or manhole steps shall be cast into the manhole barrel when the manhole barrel is poured unless approved otherwise, in writing, by the City. Concrete reducing sections shall not be used. Concrete extension collars shall be used to bring the manhole ring and cover up to approved street or ground surface elevation.

Concrete used in the manufacturing or construction of manholes shall be a minimum of Class A concrete in accordance with Chapter of these STANDARDS AND SPECIFICATIONS.

Precast manhole risers and cones shall be manufactured in conformity with ASTM Designation C-478.

4.64.02 Manhole Rings and Covers

All cast iron manhole rings and covers and other iron castings shall be made of gray pig iron conforming to ASTM Designation A-48 and shall be free from cracks, holes, swells and cold shuts and shall have a smooth finish. Fittings shall be hot dipped in asphalt varnish meeting Federal Specification TT-V-51a or joint Army-Navy Specification JAN-P-450 in such a manner as to form a firm and tenacious coating. Cast iron manhole rings and covers shall have a combined weight of not less than 400 pounds. All metal-bearing surfaces between the ring and cover shall be machined or fabricated to ensure good seating.

4.64.03 Manhole Base Slabs

Manhole base slabs may be poured in place or precast. The slab shall be designed to uniformly support AASHTO H-20 traffic loading and any earth loading. The minimum slab thickness shall be eight inches below bottom of the pipe and 2-inches above the top of the pipe. The minimum reinforcement when required in the base slab shall conform to the detail drawings in the Appendix of this chapter.

4.64.04 Joint Material

Joint material used to set barrel sections shall be a flexible buytl resin joint sealing compound meeting Federal Specifications SS-S-00210(210-A) and AASHTO M 198-B.

4.64.05 Mortar

Mortar used in repair of precast sections shall be composed of one part Portland Cement and not more than three nor less than two parts of fine aggregate. Hydrated lime or masonry cement shall not be used. Portland cement shall meet the requirements of ASTM C-250, Type II. Fine aggregate shall consist of well-graded natural sand having clean, hard, durable, uncoated grains, free from organic matter, soft or flaky fragments or other deleterious substances. The fine aggregate shall be thoroughly washed and shall be uniformly graded from coarse to fine with a minimum of 95 percent passing a No. 4 sieve and a maximum of seven percent passing a No. 100 sieve.